



Indian major carp *Labeo rohita* (Hamilton, 1882) toxicology approaches on overview

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Abstract

Indian major carp *Labeo rohita* is used for the various toxicology experiments in life science and medicine field to be consumed major food sources and highly rich proteins present in the Indian major carp. Many toxicology approaches made in lower animals used to toxicants like herbicide, pesticide, insecticide heavy metals etc., Behavior studies, hematology studies, enzyme studies, recovery studies, histology studies, immunological studies, etc., this amassed data may be helpful for the researchers to attention on the significant areas of research yet to be revealed. Widespread information about the animal has been together from various sources like books, Journals and authentic classical texts, etc. Researcher and pharmacologist and toxicological treatment may be helpful security of the whole fish was settled in the criticism.

Keywords: behavior studies, hematology studies, enzyme studies, recovery studies, histology studies, immunological studies

Introduction

Water pollution is usually caused by various human sources, typically (point and non-point) industrial facilities and agrochemicals especially in aquatic ecosystem, has grown up to be a serious environmental problem nowadays. Adversely human activities are directly or indirectly affect the environment. Developed and developing which are progressing rapidly in the field of agriculture, technology and industries are continuously releasing numerous kinds of harmful substances into the biosphere and thereby causing a severe threat to the environment (V Tamizhazhagan & Pugazhendy, 2016b) ^[97]. Pesticides are commonly used in modern agriculture to aid in the production of high quality food. However, some pesticides have the opportunity to cause serious health and environmental damage (V Tamizhazhagan & Pugazhendy, 2015) ^[77, 95]. These agrochemicals and industrial discharges may carry away effectively by rain, wind, rivers and floods into the large water bodies and change their physico-chemical properties (V Tamizhazhagan & Pugazhendy, 2016a; Vijayan, Senthilmurugan, Pugazhendy, & Tamizhazhagan, 2018) ^[96] with extreme toxicity. The water contamination cause damages to aquatic life especially to fishes which are very sensitive to wide range of toxicant in the water (Herger *et al.*, 2008) ^[91].

The industrial development and rapid urbanization have led to development of polluted zones discharging potentially toxic compounds in the environment. Especially, indiscriminate use of pesticides resulted in contamination of aquatic system has now become a global problem and is being extensively researched worldwide (V Tamizhazhagan & Pugazhendy, 2016b) ^[97]. The pollution of environment due to use of pesticides has become an increasing problem over the last century with the development of industry, agriculture and increase in population (Pugazhendy, Revathi, Prabakaran, Murugan, & Hwang, 2008) ^[92]. Aquatic water bodies are frequently adulterated with a multiple of potentially hazardous

substance (Cattaglin and Fairchild 2002) ^[17]. Pesticide poisoning is part of the main causes of morbidity and mortality in developing states. Now a day's farmers are using the verity of pesticide, insecticide, herbicide using agricultural field and seed germination (Senthilmurugan, Sattanathan, Vijayan, & Tamizhazhagan, 2018) ^[93]. Pesticides are generally used in contemporary agriculture to aid in the manufacture of high quality food (Vairakkannu Tamizhazhagan, 2017). The pesticide is mainly two type's organochlorine and organophosphate in recent year monocrotophos are organophosphate using their field of controlling the insect pest (V Tamizhazhagan & Pugazhendy, 2015) ^[77, 95]. The majority of these poisonings occur in developing countries where less protection against exposure is made. Knowledge of health risk and safety use is limited or even unknown (Jayalakshmi *et al.*, 2017) ^[36]. Organophosphates are most preferred insecticides in agriculture due to their effectiveness, less persistent life and easy detoxification in animal tissues which directly inhibit AchE (Acetylcholinesterase) activity alkaline phosphate and acid phase were both cell were gradually decreased observed by in fish and other aquatic organism (Vairakkannu Tamizhazhagan, 2017). Fishes (Fig No1) are widely used to evaluate the health of aquatic ecosystems because pollutants build up in the food chain and are responsible for adverse effects and death in the aquatic systems (Usha *et al.*, 2017) ^[81]. The random use of different pesticides often causes a lot of damage to non-target organism. Organophosphate pesticides constitute a large proportion of the total synthetic chemicals employed for the control of pests in the field of agriculture, veterinary practices and public health (Padmapriya *et al.*, 2017) ^[59].

Pesticides are well established as an efficient approach to control pests. At the same time of such chemicals are highly toxic to other species in the environment (Tamizhazhagan, 2015) ^[77, 95]. Recent studies have proved that extremely low quantities of pesticides which enter the aquatic environment

can affect productivity of organisms to kill eggs and larvae. The contaminations affect all groups of organisms in an aquatic ecosystem like invertebrate (Meenambal and Pugazhendy 2012) ^[48]. The heavy metal and pesticide contamination of aquatic system has attracted attention of researchers to all over the world and has increased in the last decades due to extensive use of them in agricultural, chemical and industrial processes that are becoming threats to living organisms (Dutta and Dalal, 2008) ^[24]. Highly reactive electrophilic components can be removed they covalently bind to tissue nucleophilic compounds which would be translated into the toxic effects. Acid phosphatase on the other hand is a phosphatase which frees attached phosphate groups from other molecules during digestion. It is a lysosome, hydrolytic enzyme with an acid pH optimum. It takes part in the dissolution of dead cells and as such serve as a good indicator of stress condition in the biological system (Viran *et al.*, 2003) ^[85].

In humans and experimental animals significant accumulation of lead acetate in the blood and tissues occur following environmental exposure (Areola *et al.*, 1999) ^[10]. Lead acetate poisoning is the most significant environmental health problem children may appear inattentive, hyperactive and irritable even at minimal lead acetate exposure. Children with greater lead acetate levels may be assigned with delayed growth, decreased intelligence, Short-term memory and hearing loss. At higher levels, lead acetate can cause permanent brain damage and even death (Cleveland *et al.*, 1999). To boost antioxidant levels, food is always favored over supplements mainly because it contains thousands of antioxidants, in contrast to supplements, which are generally rich in a single or a few antioxidants (Pichaimani *et al.*, 2017) ^[60]. Aquatic ecosystems that run through agricultural areas have a high probability of being contaminated by runoff and ground water is available from a variety of chemicals. Highly effective pesticides are used tremendously, which are entering the aquatic environment bring multiple changes in organism by altering the growth rate, nutritional value, behavioral pattern, etc (Pugazhendy *et al.*, 2008) ^[61, 62]. The ultimate reviews have updated toxicology approaches knowledge and present scenario researchers and environmental biologist helpful to focus on water pollution controlled pollution help this review this document related to human health disease pin point monitors all related filed (Tabel No.1).



Fig 1: Morphological structure of Indian major *Labeo rohita*

Toxicology approaches

Behavior is considered a promising tool in ecotoxicology (Drummond and Russom, 1990; Cohn and MacPhail, 1996) ^[23, 19] and these studies are becoming prominent in toxicity

assessments in unicellular organisms (Tadehl and Häder, 2001) ^[73], insects (Jensen *et al.*, 1997) ^[37] and fish (Little and Finger, 1990). Most physiologic and environmental changes can induce variations in fish behavior (Israeli-Weinstein and Kimmel, 1998; Almazán-Rueda *et al.*, 2004) ^[33, 7]. Behavioral characteristics are obviously sensitive indicators of toxicant's effect. It is necessary, however, to select behavioral indices of monitoring that relate to the organisms behavior in the field in order to derive a more accurate assessment of the hazards that a contaminant may pose in natural system. The migration of the fish to the bottom of the tank following the addition of cypermethrin clearly indicates the avoidance behaviour of the fish, which was reported (Murthy, 1987) ^[50]. Dermal acute toxicity tests represent an important method for establishing criteria to evaluate water quality and therein to protect the aquatic environments (NAS/NAE, 1972) ^[52]. Acute toxicity studies are generally employed to compare the sensitivities of different species to different potency of the chemicals and to derive, by using LC50 values, ecological concentration of chemicals which could be considered 'safe'.

Table: 1 scientific classification of *Labeo rohita*

Kingdom	Animalia
Phylum	Chordata
Class	Actinopterygii
Order	Cyniformes
Family	Cyprinidae
Subfamily	Labeoninae
Genus	Labeo
Species	<i>L.rohita</i>

Toxicity data for a variety of pesticides such as organophosphate, organ chlorine, carbamide and pyrethroid pesticides have been reported for number of fish species by various authors (Anees, 1975; Arunachalam and Palanichamy 1982; Arunachalam *et al.*, 1980; Baskaran *et al.*, 1989; Roy and Dutta Munshi, 1988; Singh *et al.*, 1981; Malla Reddy and Basha Mohideen, 1989; Gurusamy and Ramdoss, 2000; Sapna Shrivastava, 2002; Nishar Shailkh and Yeragi, 2004 and Visvanthan *et al.*, 2009) ^[8, 11-13, 64, 69, 47, 29, 67, 54]. Variations in LC50 if any, under altered energy balance should reflect on the nutritional status of the animal. This would be used to assess the productivity of the aquatic medium concerned and to take appropriate corrective measures. Acute toxicity tests have been historically played a major role in assessing the effect of human activities on animals and such tests have wide applicability in evaluating the toxicity of various types and mixture of pollutant in fish and other aquatic species (Craddock, 1977) ^[21]. The parameters of short-term (toxicity) exposure are the most common measures of toxicity (Cowell *et al.*, 1972; Krebs and Burns, 1977) ^[20, 39]. The importance of potential damage to aquatic ecology by effluent has been advocated and demonstrated (Sprague, 1969) ^[70], informing through various toxicity tests used in the management of water pollution as, to estimate environmental effect of waste, to compare the toxicity of different toxicants in animal, to regulate the amount of discharge pollutant (Buikema *et al.*, 1982) ^[15].

The hexavalent chromium when present in excess amount induces toxic effects in the cells (Sugiyama, 1992) ^[46] like

genotoxicity (O'Brien *et al.*, 2001; Matsumoto *et al.*, 2004 and oxidative damage Slaninova *et al.*, 2014; Patil and David, 2013; Lushchak *et al.*, 2008) [66, 2, 82, 56]. Oxidative damage primarily occurs through production of reactive oxygen species (ROS) and can damage lipids, proteins, and DNA contributing to loss of activity and structural integrity of enzymes and may activate inflammatory processes (Barzilai and Yamamoto, 2004) [1]. In most cases, the abnormal generation of ROS, which can result in significant damage to cell structure, is considered as an important signal of oxidative damage (Das *et al.*, 2014). Oxidative stress is induced as a result of the three factors: (a) an increase in oxidant generation, (b) a decrease in antioxidant protection, and (c) failure to repair oxidative damage (Velma and Tchounwou, 2010) [83]. Superoxide (O_2^-), one of the parental forms of intracellular ROS, is a very reactive molecule, but it can be converted to H_2O_2 by superoxide dismutase (SOD) and then to oxygen and water by several enzymes including catalase (CAT) and glutathione reductase (GR). Therefore, examining the change in activity of antioxidant enzymes such as SOD, CAT, and GR shall be an effectual method of denoting oxidative stress and changes in their activity and other biomarkers could be the possible tools in aquatic toxicological research.

Aquatic ecosystem of animals

The evaluation of toxic effects of metals in terrestrial and aquatic ecosystems is one of the imperative areas of ongoing research and there is an emergent concern on the development of technique for detection of toxic effects in aquatic animals (Karadede, 2000) [30]. Fishes are an important source of human diet and numerous studies have been carried out on metal pollution in different edible fish species (Erdoğan and Ayfer, 2006; Ashraf *et al.*, 2012) [55, 45]. Industrial effluents, agricultural runoffs, transport, burning of fossil fuel, and domestic wastes append to the heavy metal in the water bodies owing to their easy uptake into the food chain and bioaccumulation processes. The toxic effects of heavy metals have been examined, including bioaccumulation (Sultana and Rao, 1998) [63] and the instance of metal accumulation in fish tissues can be utilized as effective indicators of environmental contamination (Vutukuru, 2003.) [65]. Many authors have advocated using the oxidative biomarkers in assessing the health of aquatic life (Nussey, 2000) [28] and more in depth studies are necessary for an exact cause effect relationship. Therefore, to study the effectiveness of this way, a laboratory study was conducted in the fish *Labeo rohita* as a function of heavy metal chromium.

Aquatic pollution of pesticide

The rationale of this research is to study the chromium induced oxidative stress along with some biometric assays and to quantify the accumulation of chromium in different tissues of *Labeo rohita*, a most common edible carp fish, and correlate the concentration of metals with respect to their toxic effects on various fish species. The acquired information would further help in the formulation of strategies for treating chromium polluted water bodies and making the river water safe for survival of aquatic life. The potential harmful chemicals or substances such as heavy metals, pesticides and hydrocarbons are dumped either or released into the water

bodies (Ullah *et al.*, 2014) [80]. When these pollutants flow into water bodies in higher concentration than permissible limits when these results in the form of heavy mortality of all life forms residing in those aquatic systems such as fish and shell fish etc. while in lower concentration these lead to bio accumulation of these pollutants and ultimately go through the food web to human beings (Xie *et al.*, 1996; Morel *et al.*, 1998; Abedi *et al.*, 2013) [88, 49, 3]. This issue is attention seeking and should be treated and focused properly and attentively in order to ensure safer fish consumption on priority basis (Yousaf *et al.*, 2013; Ullah *et al.*, 2014) [89, 80].

Organophosphates like dichlorvos are highly toxic to fish and other non-target aquatic organisms and are powerful nerve poisons, since they inhibit AChE activity in the nervous system by blocking synaptic transmission in cholinergic neurons with disruption of the nerve function causing parasympathetic disorders and death of the organism (Nguyen *et al.*, 2008). Fishes are the most important inhabitants of the aquatic ecosystems which are more frequently exposed to and affected by these toxic pesticides (Scott and Sloman, 2004) [68], because it is believed that regardless of where the pollution occurs, it will eventually end up in the aquatic environment (Firat *et al.*, 2011) [27]. Pesticides can accumulate in fish and affect human health to via ecological cycling and biological magnification (Chebbi and David, 2011) [18]. Ecotoxicological investigations are required to determine the toxicity and potential risk of these toxic chemicals utilizing various biomarkers in fish for monitoring the quality of the aquatic environment thereby health of organisms inhabiting those aquatic ecosystems. Against this background, the present review was aimed at various ecotoxicological aspects of dichlorvos reported in fish including behavioural, histopathological (Tamizhazhagan *et al.*, 2016) [75, 78, 79], haematological (Tamizhazhagan, 2015) [77, 95], biochemical alterations (Tamizhazhagan *et al.*, 2016) [75, 78, 79] and other toxic effects. As a consequence of human activities like mining, improper waste disposal and fuel combustion, our environment is becoming more and more contaminated with toxic heavy metals.

The aquatic environment receives wastes and might be the ultimate depository for these anthropogenically remobilized heavy metals (Olsson *et al.*, 1998) [57, 58]. Heavy metals are characterized as metallic elements that have a relatively higher density in contrast to water Fergusson (1990) [25]. They are likewise regarded as trace elements Kabata- Pendia 2001 [38]. Various factors enhance their detrimental effect and may involve the age of a particular species, sex of an individual, the concentration of dose, route of exposure as well as various biological and physiological adaptations performs an essential part (Verkleji, 1993) [84]. On account of their high level of toxicity chromium, lead, mercury, arsenic and cadmium, rank among the priority metals that are of particular health significance. These metallic elements are viewed as systemic toxicants that are known to incite numerous organ damages, even at lower levels of exposure (Olsson *et al.*, 1998) [57, 58]. Heavyweight metal influence cellular organelles and various enzymes involved in the metabolic process, detoxification, and damage repair (Wang and Shi, 2001) [87]. Metal ions also destroy DNA molecule and nuclear proteins that may possibly lead to carcinogenesis or apoptosis (Beyersmann and Hartwig,

2008)^[14] Heavy metals are environmentally present everywhere, readily get dissolved in water and are the major persistent element in the aquatic ecosystem. The major component of most aquatic habitats is fish and they are considered as bio-indicator of heavy metal levels in aquatic environment (Alinnor and Obiji, 2010; Tabinda *et al.*, 2013)^[6, 72]. The fresh water ecosystem occupies an extremely small area in comparison to marine ecosystem. Fresh water resources now a day's degraded at a very large scale, due to water pollution (Ahmed *et al.*, 2011)^[5] Developing countries are tackling the problem of water pollution due to the rapid spread of industrialization and civilization. These industries produce a large amount of polluting products especially heavy metals that are constantly drained untreated into nearby rivers. The impact of heavy metals on water ecosystem has turned out to be a global concern (Yousafzai *et al.*, 2008)^[90]. Although toxicants impair the metabolic and physiological activities of the organisms, physiological studies alone do not comply with the complete understanding of pathological conditions of tissues under toxic stress. Hence it is advantageous if an insight into histological analysis. The extent of severity of tissue damage is a consequence of the concentration of toxicant and is time dependent. Also the severity of damage depends on the toxic potentiality of a particular compound or pesticide accumulated in the tissues the organisms developed a protective defense against the deleterious effects of essential and inessential heavy metals and other xenobiotics that produce degenerative changes like oxidative stress in the body (Abou EL-Naga *et al.*, 2005; Filipovic and Raspor, 2003)^[4, 26].

A variety of contaminants including toxic heavy metals (cadmium, copper, mercury and zinc) is said to be ubiquitously present in rivers, reservoirs and are disadvantageous for aquatic organisms (Olsson, 1998)^[57, 58]. In general, they are not biodegrade and therefore, their bioaccumulation in fish, oyster, mussels, sediment and other components of aquatic ecosystems have been recorded from all over the world. It appears that problem of heavy metals accumulation in aquatic organisms including fish needs continuous monitoring and surveillance owing to biomagnifying potential of toxic metals in human food chain (Das and Kaviraj, 2000; Laxi, 2005; Jayakumar and Paul, 2006; Kumar *et al.*, 2007; Kumar *et al.*, 2008)^[22, 43, 35, 40, 42]. Environmental protection has attracted the attention of the inclusive cross-section of people all over the world which has now become a global issue amongst scientists and researchers working in this area. Unfortunately several toxic pollutants, few are even unknown or un-identified to the biota, are being regularly introduced in large quantities into the environment, especially into the aquatic environment. Pollution of water by pesticides is an essential dimension of ecological degradation. The disposal of industrial and agricultural wastes directly into the aquatic medium burdens the ecosystem and emphasises the need to analyze, the concentration of these substances in the medium as well as in the organisms. It estimates that approximately 3000000 people are exposed to the effects of organophosphates or carbamates every year worldwide, which leads to up to 300000 deaths (Nagaraju Bantu and Rathnamma vakita, 2013)^[51]. Pesticides are also available to be highly toxic not only to fish but also to other organisms which

constitute food for the fish.

Conclusion

Labeo rohita is used as an important toxicology approaches to provide significant results in the scientific field to help to monitor aquatic lower animal to higher animals. In the food chain to relate to human. To help the veracious studies formulate new ideas and innovative of common people may be using this review approach.

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